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Naval Research Laboratory

PULSED LASER SEE testing

At a Glance

What is it?

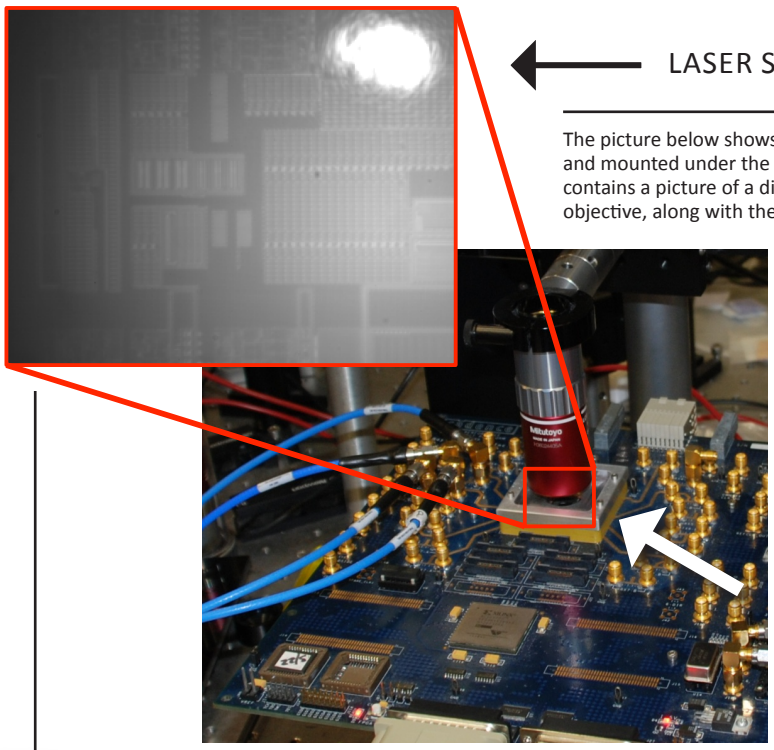
Pulsed laser systems for generating short pulses of light suitable for doing single event effects (SEEs) testing of integrated circuits - one for testing from the top side, the other for testing from the back side.

How does it work?

Short pulses of light are focused to produce a small spot that is positioned on areas of the IC sensitive to SEEs. When light is absorbed in the semiconductor charges are created that disturb the voltages at sensitive nodes, leading to either destructive or non-destructive SEEs. This is analogous to what happens when heavy ions in the radiation environment of space pass through sensitive nodes in the IC.

What will it accomplish?

The lasers provide detailed spatial and temporal information on SEEs sensitivity in ICs. Spatial information is obtained by scanning the focused light across the surface of the IC. Temporal information is obtained by using a trigger from the laser as the clock for the IC and adding various amounts of delay to shift the arrival time of the light relative to that of the clock.



The picture below shows a test board electrically connected and mounted under the laser objective, while the inset contains a picture of a die under test, as viewed through the objective, along with the focused laser spot

NRL's pulsed laser used for testing ICs from the top side generates light pulses with nominal pulse width of 1 ps, wavelength of 590 nm, and spot size just over 1 µm in diameter. The device under test is mounted on an X-Y stage that can be programmed to scan areas of the chip with step sizes as small as 0.1 µm. The energy can be varied continuously to provide equivalent LETs from less than 1 MeV·cm^2/mg to > 500 MeV·cm^2/mg. Whole chips can be scanned to find SEE sensitive areas and those areas can then be investigated more closely by using smaller step sizes over localized areas. The scanning system is under the control of a computer that can be integrated into test equipment to find the conditions under which the device is sensitive to SEEs. Beam energy is monitored continuously and beam characteristics, such as spot size, can be measured before or after the test.

The second laser is used primarily to irradiate from the back side when testing devices where access from the top side is blocked, such as in ball-grid array packages. The photon energy is smaller than the bandgap of silicon so no absorption takes place as the light propagates. However, if the beam is focused to a sufficiently small spot (~1 µm)and the pulse is sufficiently short (120 fs), the localized intensity at the focal point is so high that non-linear effects contribute to the absorption of light and in the process charge is created that can lead to SEEs.

Research Challenges and Opportunities

- Test linear devices for worst-case single event transients
- Test CMOS circuits for single event latchup
- Investigate charge sharing among closely spaced transistors
- Confirm single event mitigation approaches